Adult Chinook Escapement Assessment Conducted on the Nanaimo River During 2008

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ADULT CHINOOK ESCAPEMENT ASSESSMENT CONDUCTED ON THE NANAIMO RIVER DURING 2008

by

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TABLE OF CONTENTS

LIST OF TABLES iv

LIST OF FIGURES vi

ABSTRACT vii

INTRODUCTION 1

METHODS 3

MARK-RECAPTURE AND BIOLOGICAL DATA COLLECTION 3
SWIM SURVEYS 4
AERIAL SURVEYS 5
FIRST NATIONS FOOD FISHERY 5
WATER MANAGEMENT PLAN 5

RESULTS 6

CARCASS MARK-RECAPTURE 6
Fall Run Assessment 6
Potential Biases 6
Summer Run Assssment 7
SWIM SURVEYS 7
AREA UNDER THE CURVE 8
AERIAL SURVEY 8
FIRST NATION FOOD FISHERY 9
BROODSTOCK REMOVAL 9
BIOLOGICAL DATA 9
WATER MANAGEMENT PLAN 11
POPULATION ESTIMATE 11

DISCUSSION 12
CARCASS MARK-RECAPTURE 12
Fall Run Assessment 13
Summer Run Assessment 14
SWIM SURVEYS 14
AERIAL SURVEY 14
FIRST NATIONS FOOD FISHERY 14
BIOLOGICAL DATA 15
WATER MANAGEMENT PLAN 16
POPULATION ESTIMATE 16

ACKNOWLEDGEMENTS 18

REFERENCES 19

TABLES 21

FIGURES 40

LIST OF TABLES

Table 1. Nanaimo River daily discharge[1] (m^3/s), 2008.....22

Table 2. Daily summary of fall run Chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2008.....23

Table 3. Petersen estimates of fall run lower Nanaimo River Chinook escapement by sex, 2008.....23

Table 4. Swim survey counts for adult Chinook with observer efficiency, and system estimates, conducted on the Nanaimo River, 2008.....24

Table 5. Aerial Surveys conducted on the Nanaimo River, 2008.....24

Table 6. 2008 Nanaimo River Hatchery broodstock collection summary for fall and summer run Chinook.....24

Table 7A. Length-frequency of fall run Chinook sampled during carcass recovery, lower Nanaimo River, 2008.....25

Table 7B. Length-frequency of First Lake summer run Chinook sampled during carcass recovery, upper Nanaimo River, 2008.....27

Table 8A. Summary of age data from fall run Chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2008.....29

Table 8B. Summary of age data from First Lake summer run Chinook sampled during the carcass mark-recapture program, upper Nanaimo River, 2008.....29

Table 9. Percentage of the tag application sample recovered on the spawning grounds, by application period and sex, lower Nanaimo River, 2008.....29

Table 10. Length-frequency of fall run Chinook sampled at the Nanaimo River Hatchery, 2008.....30

Table 11A. Summary of age data from fall run Chinook broodstock collection, lower Nanaimo River, 2008.....32

Table 11B. Summary of age data from First Lake summer run Chinook broodstock collection, upper Nanaimo River, 2008.....32

Table 12. Coded-wire tag data from fall run Chinook sampled on the spawning grounds, lower Nanaimo River, 2008.....33

Table 13. Coded-wire tag data from Chinook sampled at Nanaimo River Hatchery, 2008.....34

LIST OF TABLES (continued)

Table 14. Nanaimo River Hatchery Chinook release data for brood years 1997 - 2007 35

Table 15. Chemainus River and Cowichan River Chinook release data for brood years 2002 - 2007 37

Table 16A. Total adult Chinook returns to the Nanaimo River, 1975 - 2008 38

Table 16B. Total jack Chinook returns to the Nanaimo River, 1995 - 2008 39

LIST OF FIGURES

Figure 1. Nanaimo River study area 41

Figure 2. Swim survey and mark-recapture sites on the lower Nanaimo River 42

Figure 3. Daily Nanaimo River discharge (m^3/s) during the fall run Chinook season, 2008 43

Figure 4. Monthly Nanaimo River discharge (m^3/s) in 2008 along with historical (1965 – 2008) mean 43

Figure 5. Expanded (for observer efficiency) and raw swim survey counts, lower Nanaimo River in summer/fall 2008 44

Figure 6. Annual natural and enhanced contributions to fall run adult Chinook escapement, Nanaimo River 1982 – 2008 44

Figure 7. Annual comparisons of fall run adult Chinook population estimates generated by fence information and mark-recapture pooled Petersen calculations (with 95% confidence intervals), lower Nanaimo River, 1995 - 2006 45

Figure 8. Annual adult fall and summer run Chinook escapements in the Nanaimo River 1975-2008 45

ABSTRACT

Damborg J.G., and Carter E.W. 2009. Adult chinook escapement assessment conducted on the Nanaimo River during 2008. Can. Manuscr. Rep. Fish. Aquat. Sci. 2873: viii + 45 p.

In 2008, Fisheries and Oceans Canada in co-operation with Snuneymuxw First Nation and Nanaimo River Hatchery continued an escapement study of Chinook salmon (*Oncorhynchus tshawytscha*) in the Nanaimo River. Areas of concentration for this study included: i) calculating Petersen population estimates through carcass mark-recapture surveys for fall run Chinook; ii) generating an area-under-the-curve population estimate by conducting swim surveys in the lower Nanaimo River for fall run Chinook; iii) enumerating summer run Chinook by aerial and snorkel surveys; and iv) collecting biological and coded-wire tag (CWT) data. The estimated total return of fall run adult Chinook to the Nanaimo River was 2,481 of which 200 were collected for broodstock purposes leaving 2,281 to spawn naturally. No Petersen mark-recapture study was performed in the upper river on the First Lake summer run Chinook due to limited resources. A snorkel survey and overflights estimated the naturally spawning population of the summer stock to be 506 fish plus 189 fish collected for hatchery broodstock for a total return of 695 fish. The total return of all adult Chinook, including First Nation catch, naturally spawning fall, summer and spring run, and hatchery removals, to the Nanaimo River system in 2008 was 3,896 fish, the highest return since 1975.

RÉSUMÉ

Damborg J.G., and Carter E.W. 2009. Adult chinook escapement assessment conducted on the Nanaimo River during 2008. Can. Manuscr. Rep. Fish. Aquat. Sci. 2873: viii + 45 p.

En 2008, Pêches et Océans Canada, en coopération avec la Première Nation Snuneymuxw et l'écloserie de Nanaimo River, a poursuivi l'étude sur l'échappée du saumon quinnat (*Oncorhynchus tshawytscha*) dans la rivière Nanaimo. L'étude visait quatre buts : i) obtenir une estimation des effectifs de la remonte de quinnats d'automne selon la méthode de Petersen par le biais de relevés de dénombrement des carcasses des individus marqués; ii) obtenir une estimation de la population d'après la surface sous la courbe par le biais de relevés de dénombrement en plongée libre des quinnats d'automne présents dans le cours inférieur de la rivière Nanaimo; iii) dénombrer les quinnats d'été par relevés aériens et en plongée et iv) recueillir des données biologiques et des données de micromarques magnétisées codées. Selon les estimations, la remonte de quinnats adultes d'automne dans la rivière Nanaimo totalisait 2 481 individus, dont 200 ont été prélevés pour alimenter le stock de géniteurs, pour un nombre de 2 281 individus frayant naturellement. En raison de ressources limitées, nous n'avons pas fait d'étude, selon la méthode Petersen, du nombre de quinnats d'été marqués-recapturés du lac First dans le cours supérieur de la rivière. Nous avons utilisé les résultats d'un relevé en plongée, ainsi que les données recueillies lors de relevés aériens, pour estimer les effectifs de la population de quinnats d'été qui se reproduisent naturellement. Ce nombre se chiffrait à 506 poissons, en plus des 189 poissons recueillis pour alimenter le stock de reproducteurs d'écloserie, et la remonte totale atteignait 695 poissons. En 2008, dans le réseau de la rivière Nanaimo, la remonte totale de quinnats adultes incluant les quinnats d'automne, d'été et de printemps se reproduisant naturellement, ainsi que les prises des Premières Nations et les prélèvements d'écloseries, se chiffrait à 3 896 individus, ce qui représente la plus forte remonte depuis 1975.

INTRODUCTION

Since 1988, considerable interest has been focused on the status of Chinook salmon (*Oncorhynchus tshawytscha*) stocks in the lower Strait of Georgia. The Nanaimo River, Cowichan River and the Squamish River, were chosen to represent the lower Strait of Georgia as exploitation and escapement indicator rivers (PSC 1990). Escapement information is used to evaluate rebuilding strategies and harvest management policies for lower Strait of Georgia Chinook (Farlinger et al. 1990). Since then, due to logistical reasons, the Squamish River system was dropped as an indicator. The Nanaimo River system was also discontinued as an exploitation rate indicator in 2002 and the enumeration fence was discontinued the following season in 2003. However, the Nanaimo River system remains an important escapement indicator for lower Strait of Georgia Chinook with the unique distinction of monitoring one fall and two spring runs.

In 2004 the Cowichan River lost all its brood stock due to heavy snowfall resulting in a power and pump failure. Therefore no fry were available to be coded-wire tagged from Cowichan. As an alternative, Nanaimo River fry were marked and the river became the surrogate indicator river for that brood year. Over the past five years, the system has been comprehensively assessed using alternative escapement methods (i.e. Area Under the Curve and Petersen mark-recapture) to estimate the Chinook population returning to the watershed. In 2008, DFO, Science Branch, in conjunction with Snuneymuxw First Nation and the Nanaimo River Hatchery continued to operate carcass mark-recapture and swim survey programs to collect Chinook escapement and coded-wire tag information.

Nanaimo River Chinook exhibit a variety of life history strategies, with at least three genetically distinct runs produced (Carl and Healey 1984). Unique to only a few systems on the East coast of Vancouver Island, there are two distinct spring Chinook stocks and one fall run stock returning to the Nanaimo River (Figure 1).

The two spring run stocks enter the river between March and August and hold in First Lake, Second Lake or deep canyon pools until they spawn during late summer/early fall (Blackman 1981, Brahniuk et al. 1993, Nagtegaal and Carter 2000). The upper Nanaimo River spring Chinook stock spawns upstream of Second Lake to Sadie Creek, at the outlet of Fourth Lake, in October (Hardie 2002). The majority of fry are stream-type which rear for up to one year before out-migrating to the estuary (Healey 1980, Blackman 1981, Nagtegaal and Carter 2000).

The First Lake summer run spawns within the first 1.6 kilometers downstream of the First Lake outlet to the Wolf Creek junction pool (Healey and Jordan 1982, Hardie 2002). The peak of spawning is typically during the first two weeks of October (Nagtegaal and Carter 2000, Brahniuk et al., 1993). Chinook fry produced from the late spring run are mostly ocean-type and rear for 90 days in freshwater before migrating to sea. Stream-type fry will be more vulnerable to changes in freshwater productivity and habitat conditions than ocean-type fry that out-migrate upon emergence. Once in the estuary, First Lake fry exhibit greater agonistic behaviour than fry produced by the lower Nanaimo stocks due to their longer period of territorial stream residence prior to migration into the estuary (Taylor 1990).

The larger fall Chinook stock enters the Nanaimo River during August/September and a large proportion of the run spawns in the lower river downstream of the Borehole/lower canyon area down to the Cedar Road Bridge (Healey and Jordan 1982, Hardie 2002). Some of the fall Chinook run ascend the falls to spawn in the upper river downstream of First Lake. The majority

(99%) of fry incubated in the lower river exhibit ocean-type life history strategy and out-migrate to sea upon emergence to rear in the estuary (Healey and Jordan 1982).

Hatchery production of Chinook on the Nanaimo River began in 1979 (Cross et al. 1991). In that first year, eggs were incubated at the Pacific Biological Station and later released into the river. The first year of production at the hatchery facility was 1980 (1979 brood) when 100,000 fall run Chinook fry were released. Over the years fry production has increased, and in 2008, a total of 134,552 fall run Chinook fry and 229,551 summer run Chinook fry were released into the Nanaimo River and First Lake, respectively. There is no hatchery enhancement for the Nanaimo River spring run Chinook stock.

Coded-wire tagging of Chinook began in 1979 and by 2004, 75.6% of fall run Chinook fry carried coded-wire tags (CWT). The 2004 brood at Cowichan River Hatchery perished as a result of a power outage and no fry were available for coded-wire tagging, therefore it was decided by DFO to tag the Nanaimo River fish as a surrogate for that brood year. No coded-wire tagged Chinook fry have been released since 2005.

In addition to Chinook, the Nanaimo River also supports stocks of coho salmon (*O. kisutch*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), steelhead trout (*O. mykiss*), cutthroat trout (*O. clarki*), and Dolly Varden char (*Salvelinus malma*).

In consultation with various user groups, the B.C. Ministry of Environment, Lands and Parks initiated a Nanaimo River Water Management Plan in June of 1989. The primary goal of the plan was to improve salmon escapement by increasing flows during typically low water levels in the fall while at the same time maintaining adequate flows to satisfy industrial and domestic water use (Ministry of Environment, Lands and Parks 1993).

The objectives of the 2008 escapement study included:

1. Providing fall run, First Lake summer run, and spring run Chinook salmon estimates for the Nanaimo River watershed,
2. Estimating the Snuneymuxw First Nation food fishery catch,
3. Recording hatchery broodstock removals of fall and summer run Chinook,
4. Implementing a carcass mark-recapture study for both fall run and First Lake summer run Chinook,
5. Collecting biological data, recovering CWT's, and
6. Generating an area-under-the-curve (AUC) estimate through swim surveys in the lower Nanaimo River.

This report presents the results of the escapement study completed during 2008

METHODS

Three methods were employed to estimate Chinook spawning escapement in the Nanaimo River. These included carcass mark-recapture techniques, swim surveys, and aerial surveys. The pooled Petersen mark-recapture calculation and the AUC estimate were used to generate a Chinook population estimate for fall run stocks only. Biological data including length, sex, scales, presence/absence of an adipose fin, otoliths and coded-wire tagged heads were collected from carcasses during mark-recapture and broodstock collection programs.

MARK-RECAPTURE AND BIOLOGICAL DATA COLLECTION

Escapement estimates were generated from mark-recapture data using the pooled Petersen model (Chapman modification; Ricker 1975) for fall run adult and jack Chinook. The mark-recapture also provided information on length frequencies, age composition, and sex composition. CWT data were also collected for use in calculating enhanced (hatchery) contribution in the Nanaimo River watershed.

The carcass mark-recapture operation involved a crew of three people in an inflatable boat searching the river daily for spawned-out Chinook carcasses. Each carcass was tagged with a numbered Ketchum[1] aluminum sheep ear tag on the left operculum and released into the river. Fish were also hole-punched in the left operculum to indicate they had been tagged in the event the aluminum tag was lost. For all recaptures, tag number and location were recorded. Once recaptured, the carcass was removed from the river to avoid multiple recaptures.

Biological information such as post orbital-hypural (POH) length, sex, capture location, and the presence or absence of an adipose fin were recorded. If the adipose fin was missing the head was catalogued and taken for CWT analysis at the laboratory. Five scale samples were taken from the preferred area to be analyzed for age composition (Shaw 1994). Otoliths were also collected from Chinook for examination for thermal marking to assess the possibility of strays from large scale hatcheries from the US and Canada. Chinook fry released from these hatcheries have been exposed to varying temperatures and as a result, have a distinct banding pattern on their otoliths (Hoyseth and Hargreaves 1995).

Recovery effort was concentrated on the lower portion of the Nanaimo River sampling fall run Chinook, which generally spawn between the Island Highway Bridge and the Cedar Bridge. Three days of sampling were conducted on the upper portion of the Nanaimo River targeting summer run Chinook, which spawn in a two-kilometer stretch of river between the outlet of First Lake and the Wolf Creek confluence. Though fish in this upper section were biologically sampled, no Petersen mark-recapture was completed on this stock. Therefore, the summer run estimate is based on snorkel survey data.

Biological information similar to that recorded for the carcass mark-recapture was provided by Nanaimo River Hatchery staff from Chinook collected for purposes of broodstock. This included both fall run Chinook and summer run Chinook.

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[1] Ketchum Manufacturing Ltd., Ottawa, Canada

Mark-recapture estimates were calculated using a pooled Petersen estimator. Since the true population size was unknown, a direct measure of the accuracy of the estimates was not possible. However, an assessment of the underlying assumptions of equal probability of capture, simple random recovery sampling, and complete mixing can usually be made by testing recovery and application samples for temporal, sex, and size related biases (Schubert 2000). To carry out most of the bias assessments, different gear types must be utilized for capturing the tag application and the recovery samples. In the current study, the spawning ground carcass mark-recapture was used to attain both samples thus limiting the ability to assess sample bias.

Finding sampling bias usually results in the use of a stratified estimator; however, Schubert (2000) compared the performance of several mark-recapture population estimators for a sockeye salmon population of known abundance and concluded that the pooled Petersen estimator was less biased and preferred over stratified estimators. In that study, the Schaeffer estimator would not improve accuracy and it was recommended that the method be abandoned for use in population estimation. Also, it was determined that while the maximum likelihood Darroch estimator could potentially improve accuracy, there was no obvious way of selecting between accurate and highly biased estimates. Parken and Atagi (2000) found that pooled and stratified estimators of Nass River summer steelhead produced similar escapement estimates; however the pooled estimator was more precise, and had less statistical bias than the stratified estimator. These findings indicate the robust nature of the pooled Petersen estimator and suggest that its use to determine population abundance from mark-recapture data is generally appropriate under a wide range of circumstances.

SWIM SURVEYS

Nanaimo River Hatchery staff conducted and coordinated swim surveys to provide an independent estimate of spawning Chinook and to assess spawning distribution throughout select portions of the lower Nanaimo River. Swim surveys were carried out using three or four swimmers who stay abreast of each other while moving downstream. Swimmers combined individual counts, which were recorded by pre-defined localities in the river (Figure 2).

Ten swim surveys conducted in lower portions of the Nanaimo River watershed between 25 August and 27 October were used to calculate an AUC estimate for fall run Chinook (English et al. 1992; Irvine et al. 1993). In this portion of the river, swim counts were combined into four segments.

Two other factors required in calculating an AUC estimate are survey life and observer efficiency (OE). Generally through a tagging process, a survey life statistic is generated. In the fall of 2007, tagging was carried out but soon after a major rain event caused highly turbid water in the system for a number of days. Swims were postponed, and by the time they commenced, there were few tagged Chinook remaining in the target reaches; therefore, no survey life was generated for 2007. In 2008, though water conditions were good for observing and fish distribution, fish were not holding in large numbers in the typically accessed pools and consequently too few fish were available for capture and tagging for a new survey life statistic. For all AUC calculations, the 2006 survey life of 11.53 days was used. Observer efficiency accounts for fish missed by observers. Observer efficiency varied slightly between swims, but remained high throughout the survey period as water levels stayed low to moderate and visibility was good in generally clear water.

AERIAL SURVEYS

Five aerial surveys conducted throughout the Nanaimo River watershed were focused on enumerating Chinook and chum salmon. The helicopter, an Aerospatiale A-star 350B, was flown at low altitude, approximately 300 feet (~91.4 m), to aid in visibility and identification of salmon species. Counts were made by river pool or river section and combined to obtain a final estimate. Two observers were employed for each survey. Flights took place on 30 September and 8, 14, 20, and 27 October. The first two flights covered the watershed from the estuary to Second Lake. The last three flights that covered from the estuary to the Highway 19 Bridge were mainly targeting fall chum.

FIRST NATIONS FOOD FISHERY

In 2008, two Snuneymuxw First Nation (SFN) members were hired to observe during the in-river fishery to assist in producing a total catch estimate. Minimal biological sampling of Chinook and coho caught in the river fishery was undertaken and as a result, comparing size, age and mark rates as was done in previous years, could not be completed. From SFN Guardians' observations, and post season interviews with fishers, a total catch estimate was determined.

WATER MANAGEMENT PLAN

Low flows and water levels likely result in delayed fish movement and higher water temperatures, which may potentially increase levels of disease and parasites. This is particularly true for the parasite Ich (*ichthyophthirius*), which matures more rapidly with higher temperature (Ministry of Environment, Lands and Parks 1993). During particularly low water levels, the river flow can be increased with a controlled water release.

Two man-made reservoirs in the Nanaimo River system have been utilized to increase flows during periods of low flow between late summer and early fall. Prior to 1989, water releases were conducted based on an informal arrangement between local Fisheries Officers and Harmac Pacific. Fisheries Officers would request a water release when, in their opinion, fish holding in the lower river became threatened due to low water. These requests would be granted by Harmac dependent upon the availability of water in reserve.

With the increase in population in the Nanaimo area and in an effort to satisfy domestic, industrial, agricultural, fishery, wildlife, and recreational needs, a Nanaimo River Water Management Plan (NRWMP) was initiated by the B.C. Ministry of Environment (BCMOE) in June of 1989. A team comprised of members from the BCMOE, Greater Nanaimo Water District, MacMillan Bloedel Limited, Snuneymuxw First Nation, and Fisheries and Oceans Canada (DFO) negotiated a water flow management plan (Ministry of Environment, Lands and Parks 1993). The primary water management issue has been to enhance flows to meet fisheries requirements while maintaining flows to satisfy industrial and municipal needs. This is particularly important during periods of lowest flow (September and October) and in the ten-kilometer section of river below the Harmac Pulp Operations water intake area. Increases in the fall water releases from the reservoirs since 1989 have encouraged spawning migration.

The Nanaimo River Water Management Plan also incorporates the ramping (a gradual increase and/or decrease) of water levels to minimize effects of sudden changes in river

dynamics. Possible effects include the stranding of fish, alteration of river hydrology, and erosion of riverbanks. The recommended minimum duration of a water release is 48 hours, with the optimum release time being three to four days. The recommended minimum discharge for a water release is 14.87 m^3/s (525 ft^3/s), to be released from Fourth Lake (Hop Wo et al. 2005).

RESULTS

CARCASS MARK-RECAPTURE

In 2008, the carcass mark-recapture program was completed on the lower Nanaimo River only. As in 2007, no mark-recapture was completed for the summer run Chinook stock. A second crew was not available to complete the labour intensive task of carcass mark-recapture for the summer run stock. However, three days of carcass recovery and biological sampling were completed on this stock. Daily Nanaimo River discharge for the duration of the carcass mark-recapture is presented in Table 1 and Figure 3.

Fall Run Assessment

The fall run Nanaimo River carcass mark-recapture commenced on 17 October, consisted of 15 sampling days, and was completed 6 November 2008 (Table 2). Male Chinook observed on the carcass mark-recapture were provisionally designated as an adult (Age 0.3+) or jack (Age 0.2) based on size (450 mm). The ability to divide males based on age was utilized once the scales were read.

Age information provided from scale data was utilized to decide whether fish were jacks or adults and no adults were found to be incorrectly identified. There was no differentiation made for female Chinook regardless of scale age data though all females had European ages of 0.2, 0.3 or 0.4 (Tables 8A and 8B).

During the sampling period, 121 male, 218 female, 58 jack and 3 unknown adult Chinook were tagged and released in the lower Nanaimo River (Table 2). Tagged carcasses recaptured included 48 (39.7% 12%) males, 90 (41.3% 22.7%) females, and 17 (29.3% 4.3%) jacks. Using the Petersen estimator, the total adult Nanaimo River fall run Chinook population estimate was 1169 adults (95% CI: 1008 – 1330) and 248 jack (95% CI: 151 – 347) (Table 3).

Potential Biases

The assessment of sampling selectivity had several potential biases in the carcass mark-recapture study.

1. Temporal Bias: Temporal recovery bias is assessed by stratifying application data into four discrete periods and comparing recovered and unrecovered tags to total tags applied. With a total of 15 sampling days, which cannot be evenly stratified into four equal periods, the last period has one less day than the first three. This will also help offset the fewer tags in the system at the beginning of the study. A Chi-square test was performed on males, females, and combined adults. Jacks were not assessed due to the relatively small sample size (17 recoveries over the 15-day period). A highly significant temporal bias was found with all adults; males (Chi-Square = 17.48), females (Chi-Square = 31.91), and pooled sexes (Chi-Square = 44.49).

Temporal application bias is assessed by stratifying recovery data into four discrete periods and comparing tagged and untagged recoveries to total recoveries. The same time periods were used in these calculations. A Chi-square test was performed on males, females and combined adults. No significant temporal bias was found with adult males (Chi-Square = 7.20), however, females (Chi-Square = 12.68) and pooled sexes (Chi-Square = 18.47) were found to be significantly biased.

2. Fish Sex Bias: Sex related bias was examined by comparing the sex ratios of the application samples and recovery samples for adult males, females and jacks. No sex related bias was evident when comparing male, female or jack populations between the application and recovery samples (Chi-Square = 0.92; $p < 1.0$).

3. Size Bias: Size related bias was examined by comparing the mean POH lengths of marked and recovered Chinook by sex. No significant size bias was evident in the recovery samples of adult male, female, or jack Chinook (Students t-test: $t = 0.01$; $p < 1.0$, $t = 1.58$; $p < 0.5$, and $t = 1.03$; $p < 0.5$ for males, females, and jacks, respectively).

Summer Run Asssment

Due to limited crew availability there were no mark recapture data collected for summer run Chinook. A crew did access the upper river and perform biological data collection on three days; 15, 22 and 24 October.

SWIM SURVEYS

In 2008, a total of ten swim surveys were conducted in the lower portion of the Nanaimo River to determine Chinook abundance and distribution of fall run Chinook (Table 4). Four swims were conducted in the upper Nanaimo River to determine summer and spring run abundance and distribution. Swims in the lower river began on 25 August and ended on 27 October. Most of these swims started at the Island Highway Bridge pool and ended at Raines Rock pool within tidal influence and targeted fall run Chinook. Due to high numbers of chum and few Chinook downstream of the Fire Hall pool, the final three lower river swims were shorter and included the length of river between the Island Highway Bridge pool and the Fire Hall pool. The swim targeting the spring run stock on 15 July took place in the mainstem section above Second Lake at TP Bridge, Green River and the Nanaimo River South Fork confluence. Both summer run and spring run stocks were assessed on 18 July at the Bore Hole. Two swims targeting only the summer run stock occurred on 29 August and 9 October at the South Fork/Nanaimo River confluence and downstream of First Lake to Wolf Creek, respectively.

Swim surveys conducted in lower portions of the Nanaimo River Watershed between 25 August and 27 October were used to calculate an AUC estimate for fall run Chinook. These swims were differentiated into four segments which contained multiple adjacent pools and riffle sections, specifically; Segment 1, Bridge Pool to Alder Run; Segment 2, Haslam Creek Junction to House Pool; Segment 3, Maffeo Side Channel to Fire Hall; and Section 4, Barn Hole to Raines Pool (Figure 2). Daily Nanaimo River discharge during the course of the swim surveys is presented in Figure 3.

AREA UNDER THE CURVE

In 2006, the process was completed to establish the survey life of Nanaimo River Chinook. Two reconnaissance swims were conducted prior to the tagging day and on 28 September, 145 Chinook, comprised of 45 adult males, 50 females and 50 jacks were tagged with fluorescent spaghetti tags and released in the San Salvador area. A follow up swim was conducted on 29 September to count the number of tagged fish in the system. Subsequent swims were conducted weekly to estimate the overall number of Chinook in the lower river as well as count the remaining tagged Chinook. Through this process a survey life statistic of 11.5 days was generated.

In 2007 and 2008 survey life estimates were unable to be completed. In 2007 tagging was completed, but due to a storm event delaying swims, an accurate survey life could not be derived. In 2008 insufficient fish were available for capture in the typical holding pools appropriate for seining and as a result no tagging was completed. A start date of 11 August was chosen as a time just before fall run Chinook entered the survey area (approximately ten days before the first swim). The last of the fall run Chinook were estimated to have entered the river two weeks after the last swim, yielding an end date of 10 November.

Another factor used in calculating an AUC estimate is observer efficiency, which accounts for fish missed by observers. Factors affecting observer efficiency are water turbidity, lighting conditions, as well as areas where fish can hide such as deep pools or log jams. Observer efficiency was variable during swims in 2007, ranging from 88% - 95% (Table 4). Species identification was taken into account when calculating the AUC estimate, as was the amount of habitat surveyed compared to the amount of habitat available

The calculated AUC estimate for fall run adult Nanaimo River Chinook is 2481 fish. An AUC estimate was also generated for fall run jack Chinook within the lower Nanaimo River using the same survey life (11.5 days) and observer efficiencies as adult Chinook. This methodology yielded an estimate of 895 jack Chinook. Please note both of these AUC estimates are for total returns and have not been adjusted for broodstock removals. Swim survey counts with expanded estimates are presented in Table 4 and Figure 5.

No AUC estimate was calculated for the summer run Chinook as there were not sufficient swim data collected targeting this group.

AERIAL SURVEY

Two aerial surveys (30 September and 8 October) were conducted to enumerate spawning Chinook. Three subsequent overflights (17, 20, and 27 October) were conducted primarily to enumerate chum salmon in the lower Nanaimo River. However, Chinook spawning distribution was also recorded during these flights. All flights occurred under clear conditions during low to moderate river flows. Low flows may have encouraged fish to hold in deep river pools before higher flows could aid Chinook migration to spawning areas as flights revealed very low Chinook counts. The first and second flights yielded counts of 27 and eight adult spawning Chinook, respectively, which were the highest Chinook counts for the five overflights (Table 5).

FIRST NATION FOOD FISHERY

An in-river rod and gillnet fishery for Chinook takes place in September and October to provide food, social, and ceremonial fish for the SFN. This fishery is held in a one-kilometre area downstream of the Cedar Bridge and monitored by the SFN Fisheries Guardians. In 2008, the estimated Chinook catch was 720 adults.

As in years prior to 2006, catch estimates were received from the SFN guardians, however, the guardians were unable to attain biological samples from Chinook and coho caught in this fishery in 2008.

BROODSTOCK REMOVALS

From 11 Sept to 24 Oct, Nanaimo River Hatchery's field records show 73 male, 127 female, and 52 jack fall run Chinook were collected for broodstock purposes from lower portions of the Nanaimo River (Table 6). From 29 September through to 7 October, 116 male, 73 female and 5 jack summer run broodstock Chinook were collected from First Lake. No spring run Chinook were removed for hatchery broodstock.

BIOLOGICAL DATA

During the fall run spawning ground carcass mark-recapture, 121 male, 218 female, 3 unknown adults and 58 jack Chinook carcasses were sampled and measured for post orbital-hypural (POH) length (Table 2). The lengths of adult male Chinook ranged from 45 cm to 88 cm and averaged 63.1 cm. Adult females ranged from 42 cm to 80 cm and averaged 64.5 cm. Jack Chinook ranged in length from 23 cm to 44 cm and averaged 39.4 cm (Table 7A).

A total of 5 (4.1%) male, 18 (8.3%) female, and zero (0.0%) jack Chinook were missing adipose fins (Table 7A). Age analysis (European Age) of male Chinook revealed that 36.0% were 0.1, 57.3% were 0.2, and 6.7% were 0.3 (Table 8A). Analysis of female Chinook scales indicated that 72.4% were 0.2, 26.3% were 0.3, and 1.3% were 0.4. No sampled fish had scales exhibiting over-wintering in freshwater.

During the summer run spawning ground carcass biological sampling, 66 male, 65 female, and 5 jack summer run Chinook carcasses were sampled and measured for POH length. The lengths of adult male Chinook ranged from 48 cm to 76 cm and averaged 61.9 cm. Females ranged from 54 cm to 82 cm and averaged 66.3 cm, and jacks ranged from 28 cm to 39 cm and averaged 34.5 cm (Table 7B). One jack Chinook was found missing an adipose fin in the summer run river Chinook sampling.

Age analysis of male Chinook revealed that 13.5% were 0.1, 73.0% were 0.2, and 13.5% were 0.3 (Table 8B). Analysis of female Chinook scales yielded that 63.6% were 0.2 and 36.4% were 0.3. All summer run Chinook were found to be ocean-type Chinook fry, as all scales exhibited no over-wintering in freshwater. Of fish sampled during the carcass mark-recapture operations, there was no significant difference between the mean lengths of fall and summer run male Chinook (Students t-test: $t = 1.13$; $p<0.5$), however there was a significant difference between both females and jacks when comparing summer and fall stocks. Jacks in the fall run population were on average 5.0 mm larger (Student's t-test: $t = 3.42$; $p<0.01$) and

females in the fall run population were on average 19 mm larger (Student's t-test: $t = 2.2$; $p < 0.1$).

A total of 61 adult male, 70 female, and 30 jack fall run Chinook were sampled from hatchery broodstock, measured for POH length, scale sampled and examined for adipose-clipped fins. Adult male Chinook ranged from 49 cm to 78 cm and averaged 63.1 cm. Female Chinook lengths ranged from 56 cm to 80 cm and averaged 66.7 cm, jack Chinook ranged from 35 cm to 48 cm and averaged 41.0 cm (Table 10).

Three (4.9%) adult males, 16 (22.9%) females, and one (3.3 %) jack were found to be missing adipose fins (Table 10). Ages of fish identified as male Chinook were 34.9% 0.1, 54.7% 0.2 and 10.5% 0.3. Female Chinook were 2.8% 0.1, 55% 0.2, 38% 0.3 and 4.2% 0.4 (Table 11A).

Summer run Chinook taken for broodstock from the upper Nanaimo River were aged as follows: males – 21.1% 0.1, 78.9% 0.2, females – 92.9% 0.2, 7.1% 0.3, (Table 11B). All summer run Chinook were found to be ocean-type Chinook as no scales exhibited over-wintering in freshwater.

When comparing mean lengths of female fall run Chinook recovered from the spawning grounds to female hatchery broodstock samples, it was found that the broodstock fish were significantly larger than fish from the carcass mark-recapture study (Student's t-test: $t = 2.66$; $p < 0.01$). Similarly, there was a significant statistical difference between the mean length of fall run jacks sampled at the hatchery and those from the fall run mark-recapture program (Student's t-test: $t = 2.14$; $p<0.05$), fish sampled at the hatchery were significantly larger. T-test comparisons between mean length of male Chinook sampled at the hatchery and those recovered in the mark-recapture program revealed no significant difference in mean length (Student's t-test: $t = 0.03$; $p<1$).

Comparisons between mean length of female summer run Chinook recovered on the spawning grounds and Chinook sampled from hatchery broodstock yielded no significant difference (Student's t-test: $t = 1.16$; $p<0.25$). Similarly lengths of summer run male fish sampled at the hatchery were not significantly different in size from fish sampled on the spawning grounds (Student's t-test: $t = 1.05$; $p<0.30$).

There was a significant statistical difference between the mean length of fall run jacks sampled at the hatchery and those from the fall run mark-recapture program (Student's t-test: $t = 2.14$; $p<0.1$), with hatchery samples being significantly larger. Summer run jacks could not be compared as so few jacks were sampled at the hatchery.

A highly significant difference was found between the mean lengths of female and male fall run broodstock sampled at the Nanaimo River hatchery (Student's t-test: $t = 3.37$; $p<0.001$). Females were significantly larger.

Twenty-three fall run Chinook carcasses recovered on the spawning grounds were found to have been missing adipose fins, 5 males and 18 females, 21 of which contained CWT's (Table 12). With the exception of one summer run jack from the upper river, all adipose-clipped fish were recovered from fall run Chinook. Twenty Chinook identified as having a CWT were reared at the Nanaimo River Hatchery all from the 2004 brood year. The remaining tag was from the Puntledge River Hatchery released from the 2004 brood. The single adipose-clipped jack from the summer run contained no CWT.

The Nanaimo River Hatchery found 20 fall run Chinook collected for broodstock to be missing adipose fins, denoting a possible CWT. No summer run broodstock fish were found to be marked. Seventeen of the 20 fall run Chinook heads sent in for analysis were found to contain CWT's. Of these, 11 were released from the Nanaimo River from the 2004 brood year. The remaining six fish were from 2003 and 2005 Chemainus brood, 2006 Cowichan brood, 2005 Puntledge Summer run brood, and 2005 Big Qualicum Brood (Table 13). The lack of 2003 brood year recoveries from the Nanaimo River was due to no CWT fry released in that year. For a list of Nanaimo River Hatchery fry releases, brood years 1997 – 2007, see Table 14. For fry releases to the Chemainus River and Cowichan River Watershed, brood years 2002 – 2006, see Table 15.

A comparison between female Chinook mark rates obtained from fall run Nanaimo River carcass mark-recapture and fall run broodstock collection yielded a significantly higher mark rate for broodstock fish (Chi-Square = 10.51). However, when comparing males obtained from fall run Chinook collected in the carcass mark-recapture and broodstock, there was no statistically significant difference (Chi-Square = 0.07). Also, there was no significant difference when comparing the mark rates of jacks between hatchery broodstock collection and carcass mark recapture (Chi-Square = 1.96). A comparison between male and female summer run Chinook mark rates obtained from the carcass mark-recapture and broodstock was not possible as no summer run Chinook collected were missing an adipose fin.

Otoliths were collected from 182 carcasses from the fall run (63 male, 90 female, 29 jack) and 58 from the spring run (26 male, 29 female, 3 jack) Chinook. Nanaimo River Hatchery staff collected 50 otoliths from summer broodstock in 2008. At this point otoliths have not been analysed for thermal marks.

WATER MANAGEMENT PLAN

In 2008, one scheduled water release occurred on 29 September to assist in migration of the Chinook stocks into the Nanaimo River. Due to sufficient rainfall which kept river levels elevated for most of October and November, additional water releases were not required. The average daily flow for the month of October was 17.3 m^3/s, above the target release rate for migrating salmon of ~15m^3/s. Daily Nanaimo River discharge is presented in Table 1 and Figure 3. A summary of mean monthly Nanaimo River discharge and historical monthly mean is presented in Figure 4.

POPULATION ESTIMATE

The estimated total return of Chinook to the Nanaimo River Watershed for summer and fall run stocks is 3,896 adult and 1033 jack. The number of naturally spawning fall run adult Chinook in the Nanaimo River during 2008 was determined to be the AUC swim survey estimate (2,481 fish) minus the net fall run broodstock removals (200 fish). Following this methodology, the total number of adult fall run Chinook spawning in the Nanaimo River was estimated to be 2,281 fish (Table 16A). The total return of adult fall run Chinook to the Nanaimo River was determined to be the sum of the AUC swim survey estimate (2,481 fish), plus the First Nation fishery catch (720 fish), yielding 3,201 fish. The Petersen mark-recapture calculation was also employed to estimate the fall run population. Through this methodology, the estimate was 1169 adults and 249 jacks (Table 3).

An AUC estimate for fall run jack Chinook (895 fish), minus broodstock removals (52 fish), yielded 843 natural spawners. The total return of fall run jack Chinook was determined to be the AUC estimate of 895 fish.

No Petersen mark-recapture was performed in 2008 on summer run Chinook. Using the peak count swim as the only escapement estimate, the number of returning summer run fish was estimated to be 506 adult and 133 jack (Table 5) plus the broodstock capture of 189 adult and 5 jack. This yields a total summer run return of 695 adult and 138 Jack.

The total return for all jack Chinook to the Nanaimo River was estimated to be the total fall run jack Chinook (895), plus total summer run jack Chinook (138 fish), yielding 1,033 fish (Table 16B).

The escapement estimate for the spring run stock was derived from a snorkel survey that occurred on 15 July 2008. This survey yielded a count of 253 adult and 26 jack Chinook. Given this swim survey was the only enumeration method for the spring run stock, total run size for the Nanaimo River spring stock was estimated at 253 adult and 26 jack.

The overall enhanced (hatchery) contribution is calculated by expanding the mark rate observed in the carcass mark-recapture program (deadpitch) with the ratio of marked to unmarked hatchery releases. Hatchery broodstock are not used in the calculation because the capture method is much less random than deadpitch. Total fall run Chinook (adults and jacks) enhanced contribution was determined to be 17.0% in 2008. Annual natural and enhanced (hatchery) contributions to fall run adult Chinook escapements from 1982 to 2008 are presented in Figure 6.

DISCUSSION

CARCASS MARK-RECAPTURE

Variable water conditions existed through most of the mark-recapture program, which commenced on 17 October and ended on 6 November. Water levels were relatively low during most of the mark-recapture program, averaged 22 m^3/s during the survey period and peaked at 33 m^3/s on 8 October, before commencement of the survey. The survey was ended 6 November due to rising water conditions and a large portion of chum carcasses in the system. The river peaked at 224 m^3/s on 8 November. This flood event prohibited staff from performing any further in-river activities.

Low flows during the study period do not facilitate mixing of carcasses. If the carcasses do not properly mix they are easily recaptured later on in the study resulting in a low Petersen estimate. Biases in data collection may explain the large difference in population estimates between the AUC and Petersen methods. Without proper mixing and closed containment of the population, it is easy for live or dead fish to enter and leave the sampling area biasing results. It appears that this year's data are consistent with last two year's, that is, a much higher estimate was determined from the AUC than through the carcass mark-recapture.

Fall Run Assessment

When comparing mark rates between hatchery samples to the fall run carcass mark-recapture program, a Chi-Square analysis was performed. The result indicates a significant difference between the hatchery mark rate to that of the fall run program. Hatchery samples were marked at a significantly higher rate than those recovered on the river (Chi-square = 7.08; $p<0.01$). This difference in mark rates is consistent with last year's data. It is likely the result of the area where the fish are captured for brood being different from the area sampled for carcass mark-recapture.

Significant temporal bias was found for recovery samples for males, females and pooled adults. This bias however is not entirely unexpected as through the study period more and more fish are available for recapture as more fish are marked over time. The expected bias leans towards a higher rate of recovery later in the study, which was the case in 2008 up until the last period where recovery dropped off sharply (Table 9). This sharp decline in recoveries is not unusual at the very end as fewer fish are left in the system to both be tagged and recaptured. Also, with relatively small sample sizes (as few as five recoveries in a period) used in these calculations, only a few fish may make a significant difference. There was no significant application bias for any the males, there was however a significant application bias for the females and pooled sexes. Again these biases are not uncommon being an open site, fewer fish are available for tagging late in the study.

Water discharge can play an important role in the success of the mark-recapture program and with very large fluctuations in water discharge over the sample period, mixing may be variable and access can be difficult. Also, there can be problems with predators (bears) that may remove the tagged carcasses from the sample area, especially during the beginning of the study. After some time the bears will become satiated and remove fewer carcasses, biasing the results (D. Nagtegaal, DFO Stock Assessment Biologist, 5353 Club Road, Duncan, B.C., V9L 3X3. pers. comm.).

There are also other problems associated with the use of a Petersen mark-recapture study in a river application like the one used. One of the fundamental necessities for a mark-recapture program is the population must be contained. This is not the case as live fish as well as carcasses can leave and enter the area, particularly during higher flows.

No sex related bias was evident in the application or recovery samples when male and female were compared or when all Chinook were compared, suggesting gender was not a contributing factor in the recovery of tagged carcasses.

Size bias testing did not provide an assessment of the size selectivity of the sampling method since both application and recovery samples were attained using the same method. Rather, the size bias assessment provided an evaluation of the recoverability, based on the sizes of tagged carcasses that were redistributed back into the river after tagging. Testing revealed that there were no size biases for male, female, or jack Chinook between application and recovery samples.

Summer Run Assessment

The 2008 total estimate of 695 adult summer run Chinook was nearly double the 1995-2005 average of 357 fish. The total jack population for the summer stock is estimated at 138 fish. No historical comparison can be made as no jack Chinook carcasses were recovered previous to 1995 (Hop Wo et al. 2006). It is important to note that this summer run estimate is a minimum run size, as it was determined from snorkel surveys and brood captures. It is possible that the actual run size may be significantly greater than the estimate provided. Ideally additional swims would have taken place, as with the fall run, and an AUC calculated for the summer stock.

SWIM SURVEYS

Swim surveys conducted in the lower portion of the Nanaimo River provided the primary information for generating a population estimate and spawning distribution of fall run Chinook. The last date, 10 November, used in AUC calculations, assumes that no more Chinook were available to be counted on or after this date. Any Chinook entering the system after this date would not be included in the AUC estimate. A tagging study in 2006 conducted to obtain the survey life statistic for fall run Nanaimo River Chinook, generated an estimate of 11.53 days.

The fall run jack Chinook estimate generated by AUC calculations utilized the same observer efficiency applied to adult Chinook, as no specific observer efficiency was available for jacks. As jack Chinook are physically smaller than most adults, jacks may be harder to see in the river and would therefore have lower observer efficiency, resulting in increased expansions to the estimates. Similarly, the survey life statistic of 11.53 days was intended for adult Chinook, and therefore assumes that adults and jacks are both available to be counted for the same amount of time.

Swim surveys in the upper Nanaimo River occurred in 2008 in four locations at various times during the migration and spawning period. These swims were the only method used to estimate the population of both the summer and spring run stocks.

AERIAL SURVEYS

Aerial surveys provide an independent estimate of summer run Chinook as well as spawning distribution, especially in the upper reaches of the Nanaimo River watershed. During flights targeting fall run Chinook in the lower Nanaimo River, some misidentification is possible as chum salmon are the most abundant species in the latter part of in-migration in that area. However, in the upper portions of the Nanaimo River, misidentification of Chinook is less likely, as summer Chinook are the only species to normally utilize this area of river at this time of year. Aerial estimates may include some jack Chinook. In comparison to swim surveys, aerial surveys are less reliable and therefore not used in the population estimate for any of the Chinook stocks in 2008.

FIRST NATIONS FOOD FISHERY

Catch estimation procedures developed by the Snuneymuxw First Nation have not been assessed by stock assessment staff. As a result, no comments can be made regarding the

methodologies used. The 2008 catch estimate for the SFN fishery has been determined as 720 adult Chinook and unknown jack catch. For the purpose of total river returns, this estimate will be added to the escapement. SFN catch estimates are difficult to compare year to year as methods for determining these results often change annually. In future, DFO in conjunction with the SFN intend to develop a sampling strategy to better collect effort along with catch information, allowing a more defensible estimate.

BIOLOGICAL DATA

Both mark-recapture samples and broodstock samples collected from fall run Chinook were expected to have negligible variation in lengths as they were retrieved from the same population. However, female and jack fall run broodstock were found to be significantly larger than the fish sampled on the spawning grounds. Conversely, there was no statistical difference between fall run males when comparing broodstock and fish sampled on the spawning grounds. Similarly, there was no significant difference between male or female summer run fish when comparing hatchery broodstock to fish sampled on the spawning grounds.

Due to very low jack recoveries for the summer run stock no statistical analysis was performed to compare summer run jacks.

Consistent with most years, female fall run Chinook were significantly larger than fall run males when comparing hatchery samples. This is partially due to the slightly older makeup of the female population, which contained some 0.4 age fish, whereas no 0.4 age fish were recovered from the male population. There was no significant difference between males and females of the summer run stock; however, females sampled on the spawning grounds were on average 44 mm larger than males sampled from the same location.

There was a statistically significant difference in adipose fin-clip mark rates between fall run adult Chinook obtained from mark-recapture and from broodstock collection. Hatchery adults were marked at a significantly higher rate. The mark rate for hatchery brood caught fish was 14% compared to 6% for fish sampled during the Petersen mark-recapture study. Using Chi-Square analysis to test for a statistical difference between summer run Chinook collected during mark-recapture and broodstock collection was not possible as there were no adipose-clipped recoveries at the hatchery.

Of the 37 CWT's decoded from carcass mark-recapture and hatchery broodstock collection, all but seven were released from Nanaimo River hatchery. Also, all Nanaimo released fish with CWT's were from the 2004 brood year which was the last year Nanaimo River fish were coded-wire tagged. The seven strays came from various east coast Vancouver Island (ECVI) systems including the Puntledge, Big Qualicum, and Chemainus Rivers. With fewer releases of fish containing CWT's over the last few brood years, comparing stray rates cannot be made over years. However it is interesting to note that over the past three years, only strays from the Chemainus River have been detected, whereas in 2008, fish from the Puntledge and Big Qualicum Rivers were also detected.

WATER MANAGEMENT PLAN

In previous years (1995 – 2003), water release successes were evaluated by monitoring movement of Chinook past the enumeration fence, however, since there is no longer a fence program, this was not possible in 2008. Previous successes with water releases suggest that they are beneficial in aiding and encouraging Chinook migration (Hop Wo et al. 2005). Due to sufficient flows for most of the migration period, only one scheduled release occurred on 29 September. As a result fish were observed to have spread out over the spawning area (Ted Carter, DFO Stock Assessment Technician, 3225 Stephenson Point Road Nanaimo, B.C. Pers. Comm.). Other than the 29 September release, it was not necessary to implement additional water releases in 2008, as natural flows for October were above the target flows of 14.87 m^3/s outlined in the WMP.

POPULATION ESTIMATE

The 2008 Nanaimo River fall run Chinook population estimate was based on the AUC swim survey calculation that produced estimates of 2,481 adults and 895 jacks. One of the goals of this study was to have two independent and analytical methods of estimating the population of fall run Chinook. The carcass mark-recapture program provided data to calculate a Petersen estimate. Therefore, the fall run Chinook population was estimated by both the AUC and the Petersen calculations.

Through the Petersen methodology the estimate was 1169 adults and 249 jacks. As mentioned, changing river conditions can affect mark and recapture rates; also redistribution of carcasses in the system may have been insufficient. As a result, the number recaptured may be biased high, which would lead to a low estimate. This likely explains the large difference between the AUC and Petersen estimates. For example, the peak jack count on 15 September estimated 252 jacks in the survey reach, which is above the jack Chinook Petersen estimate for the entire season. This confirms that the Petersen estimate is biased low for the jack population and is likely similar for the adult estimate.

The natural spawning estimate of fall run adult Chinook (2,281) is approximately 85% higher than the 1995-2005 average of 1,225 fish. However, given that there have been several methods used to estimate the total return, it is difficult to make true comparisons. Annual fall run adult Chinook estimates by type (fence, Petersen mark-recapture, and AUC) are presented in Tables 16A, 16B, and Figure 7.

The summer run Chinook estimate is ideally obtained by numerous swim surveys. Only three surveys were completed during the 2008 spawning season, one of which occurred in a known spawning area. Additionally, the Petersen mark-recapture estimate was not completed in 2008 as too few personnel were available to conduct deadpitch surveys. The naturally spawning estimate for summer run adult Chinook of 506 fish is well above the 1995–2005 average of 357. The 2006-2008 average of 531 fish is encouraging and ideally these numbers will continue to increase over the years to come. Annual adult Chinook escapements are presented in Tables 16A, 16B, and Figure 8.

The fall run natural spawning estimate of 843 jacks is very close to the 1995–2005 average of 856 fish. The Petersen estimate of 249 is only about one third of this ten-year

average. The estimate of 133 summer run jack Chinook for 2008 cannot be compared to historical data, which are sparse and in many years no summer run jacks were observed.

The total adult return for both summer and fall run fish including natural spawners, hatchery broodstock and SFN FSC catch is 3,896 fish. This is the highest return on record since 1975 (Table 16A), which is encouraging news for this unique ECVI watershed.

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TABLES

Table 1. Nanaimo River daily discharge[1] (m^3/s), 2008.

	Month											
Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	17.7	11.8	43.6	16.2	39.6	31.2	19.7	6.2	12.0	6.5	21.8	-
2	20.0	11.2	45.1	15.4	32.9	30.0	19.1	6.6	10.6	8.7	31.1	-
3	29.2	10.6	39.8	14.7	32.5	29.4	17.7	6.2	9.6	10.9	45.8	-
4	79.3	10.0	34.6	14.5	37.6	32.4	16.1	6.1	8.6	16.3	39.8	-
5	147.3	11.5	30.1	14.6	47.8	31.2	14.5	5.8	8.0	19.5	30.4	-
6	130.7	14.6	26.5	15.7	59.3	32.3	14.1	5.1	7.6	18.3	36.7	-
7	84.7	16.0	24.2	17.1	61.7	31.6	12.8	5.0	7.2	27.6	70.5	-
8	57.7	17.8	24.5	18.8	55.6	29.2	10.7	5.3	6.8	33.7	224.2	-
9	43.2	19.2	25.6	19.8	47.7	27.1	9.1	5.8	6.6	28.3	198.6	-
10	39.7	24.1	34.8	19.6	41.6	33.0	8.1	6.0	6.3	22.7	111.3	-
11	62.8	33.6	117.6	18.9	41.7	32.8	7.3	5.8	6.2	18.7	82.6	-
12	78.8	37.1	120.2	18.9	41.5	30.1	6.7	5.7	6.1	16.2	102.2	-
13	84.2	40.8	79.6	25.5	38.9	28.8	6.2	5.5	6.1	14.5	107.2	-
14	86.5	39.1	53.7	31.6	42.0	27.1	6.0	5.3	6.1	13.5	-	-
15	91.4	34.0	40.6	30.0	64.8	24.4	5.7	5.0	6.0	12.6	-	-
16	71.4	29.8	34.0	26.9	86.6	22.4	5.4	4.7	5.8	10.4	-	-
17	51.8	26.2	29.9	24.6	111.4	22.0	5.3	-	5.7	17.1	-	-
18	39.5	23.8	26.9	24.3	129.2	20.8	5.2	-	5.7	29.9	-	-
19	33.0	22.0	25.2	25.0	125.3	19.2	4.7	-	5.6	27.7	-	-
20	28.5	21.0	24.4	22.9	105.7	17.6	4.7	-	5.7	23.3	-	-
21	24.8	21.1	23.4	21.2	78.3	17.6	4.9	5.7	6.0	22.2	-	-
22	22.1	21.3	21.7	19.4	57.4	18.3	4.9	7.5	6.0	20.1	-	-
23	20.1	21.9	21.5	18.1	45.7	18.0	4.9	8.0	5.9	18.6	-	-
24	18.5	22.3	21.9	17.2	45.3	16.9	5.5	8.2	5.9	16.7	-	-
25	17.1	22.1	21.2	16.1	53.2	15.8	5.9	10.2	6.1	13.5	-	-
26	16.3	21.7	21.1	15.4	66.1	15.5	6.1	9.9	7.4	12.2	-	-
27	15.6	22.5	20.0	16.0	72.4	15.0	6.1	11.1	7.2	11.3	-	-
28	14.6	24.5	19.6	25.8	61.6	15.1	6.1	12.4	6.8	10.6	-	-
29	14.3	29.1	18.6	48.0	52.6	16.6	6.1	13.7	6.7	10.1	-	-
30	13.6		18.4	49.3	41.1	18.5	6.3	14.2	6.5	10.2	-	-
31	13.4		17.6		33.8		6.1	13.6		13.3		-
Total	1467.7	660.7	1106.0	661.5	1850.9	719.6	261.6	204.5	206.7	535.3	1102.0	0.0
Mean	47.3	22.8	35.7	22.0	59.7	24.0	8.4	7.6	6.9	17.3	84.8	0.0
Max	147.3	40.8	120.2	49.3	129.2	33.0	19.7	14.2	12.0	33.7	224.2	0.0
Min	13.4	10.0	17.6	14.5	32.5	15.0	4.7	4.7	5.6	6.5	21.8	0.0

[1]Data recorded at Water Survey Canada Station 08HB034 which is located upstream of the "Bungy Zone" in Cassidy, B.C.

Discharge data are preliminary and subject to revision.

Table 2. Daily summary of fall run Chinook sampled during the carcass mark-recapture program, lower Nanaimo River, 2008.

	Carcasses Examined				Tags Applied				Recaptured Carcasses			
Date	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown	Male	Female	Jack	Unknown
17-Oct	15	18	3	0	15	18	3	0	0	0	0	0
20-Oct	12	21	4	0	8	16	2	0	4	5	2	0
21-Oct	16	19	7	0	15	16	7	0	1	3	0	0
22-Oct	6	17	7	0	3	13	5	0	3	4	2	0
23-Oct	6	15	5	0	5	11	5	0	1	4	0	0
24-Oct	17	24	4	0	12	15	3	0	5	9	1	0
27-Oct	16	26	9	0	15	23	9	0	1	3	0	0
28-Oct	25	37	13	1	15	21	6	1	10	16	7	0
29-Oct	15	44	10	1	7	29	6	1	8	15	4	0
30-Oct	9	19	6	0	6	12	6	0	3	7	0	0
31-Oct	12	34	2	0	7	25	2	0	5	9	0	0
3-Nov	10	10	2	0	8	5	2	0	2	5	0	0
4-Nov	3	14	2	1	1	9	1	1	2	5	1	0
5-Nov	4	8	1	0	3	3	1	0	1	5	0	0
6-Nov	2	2	0	0	1	2	0	0	1	0	0	
Total	168	308	75	3	121	218	58	3	47	90	17	0

Table 3. Petersen fall run Chinook escapement estimates by sex, lower Nanaimo River, 2008.

	Population	95% Confidence Limits	
Sex	Estimate	Lower	Upper
Adult Male [1]	423	324	522
Female	744	616	871
Total Adult [2]	**1169**	**1008**	**1330**
Jack	249	151	347
Total Population	**1418**	**1159**	**1677**

[1] Jacks not included.

[2] Population estimate includes 2 unknown sex adults in calculation and is calculated based on 342 marked and 141 recaptured adults

Table 4. Swim survey counts for adult Chinook with observer efficiency and system estimates, conducted on the lower Nanaimo River, 2008.

		Chinook Counts				Estimated Chinook				In-River Chinook Estimate (L+D)		
Swim Date	Observer Efficiency	Live Adults	Dead Adults	Live Jacks	Dead Jacks	Live Adults	Dead Adults	Live Jacks	Dead Jacks	Adults	Jacks	Comments
25-Aug	91%	49	0	35	0	54	0	38	0	54	38	A
2-Sep	93%	192	0	74	0	206	0	80	0	206	80	A
8-Sep	94%	268	0	130	0	285	0	138	0	285	138	A
15-Sep	94%	389	0	237	0	414	0	252	0	414	252	A
22-Sep	95%	350	0	119	0	368	0	125	0	368	125	A
29-Sep	95%	419	0	214	0	441	0	225	0	441	225	A
6-Oct	88%	250	0	66	0	284	0	75	0	284	75	A
14-Oct	90%	578	0	180	0	642	0	200	0	642	200	B
20-Oct	90%	329	0	116	28	366	0	129	0	366	129	B
27-Oct	90%	141	0	43	0	157	0	48	0	157	48	B

Comments

A Lower portion of the river only, from Bridge Pool to Raines Pool.

B Lower portion of the river only, from Bridge Pool to Firehall Pool.

Table 5. Aerial Surveys conducted on the Nanaimo River, 2008

	Septeber 30				October 14 2008				October 20 2008				October 27 2008			
Location	CHUM		CHINOOK		CHUM		CHINOOK		CHUM		CHINOOK		CHUM		CHINOOK	
	Live	Morts	Live	Morts	Live	Morts	Live	Morts	Live	Morts	Live	Morts	Live	Morts	Live	Morts
Estuary to Cedar Br.	520	30	0	2	8,000	300	0	0	7,500	400	0	0	14,000	4,000	0	0
Cedar Br to Haslam Ck	410	5	24	0	9,500	500	5	30	15,000	2,100	0	0	16,000	3,000	0	0
Haslam Ck to Bungy Zone	50	0	3	0	300	10	3	3	2,000	100	0	0	3,000	500	0	0
TOTAL	980	35	27	2	17,800	810	8	33	24,500	2,600	0	0	33,000	7,500	0	0

Table 6. 2008 Nanaimo River Hatchery broodstock collection summary for fall and summer run Chinook.

Number of Fish	Fall Chinook			Summer Chinook		
	Female	Male	Jack	Female	Male	Jack
Captured	127	73	52	73	116	5
Spawned	95	80	23	63	64	1
Mort	21	6	4	0	3	1
Released	9	0	12	10	49	3
Kelt	7	0	0	0	0	0

* male & jack numbers vary due to staff judgement

Table 7A. Length-frequency of fall run Chinook sampled during carcass mark-recapture, lower Nanaimo River, 2008

Length (cm)	Males	Females	Jacks
23	0	0	1
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	1
34	0	0	2
35	0	0	3
36	0	0	3
37	0	0	7
38	0	0	6
39	0	0	8
40	0	0	4
41	0	0	6
42	0	1	11
43	0	0	4
44	0	0	2
45	1	0	0
46	0	0	0
47	0	0	0
48	0	0	0
49	2	0	0
50	3	2	0
51	1	2	0
52	1	1	0
53	2	3	0
54	4	1	0
55	5	3	0
56	1	6	0
57	4	10	0
58	3	5	0
59	7	6	0
60	6	12	0
61	7	15	0
62	14	15	0
63	9	27	0
64	8	23	0
65	10	13	0
66	8	9	0
67	8	4	0
68	2	8	0
69	1	9	0
70	0	7	0

Table 7A Continued.

Length (cm)	Males	Females	Jacks
70	0	7	0
71	1	11	0
72	2	4	0
73	0	6	0
74	1	5	0
75	3	4	0
76	1	1	0
77	1	4	0
78	2	0	0
79	2	0	0
80	0	1	0
81	0	0	0
82	0	0	0
83	0	0	0
84	0	0	0
85	0	0	0
86	0	0	0
87	0	0	0
88	1	0	0
Totals	**121**	**218**	**58**
Mean Length	63.1	64.5	39.4
Standard Deviation	7.0	6.0	3.4
Adipose Clips	5	18	0
Mark Rate	4.1	8.3	0.0

Table 7B. Length-frequency of fall run Chinook sampled during carcass mark-recapture, upper Nanaimo River, 2008

Length (cm)	Males	Females	Jacks
28	0	0	1
29	0	0	0
30	0	0	0
31	0	0	2
32	0	0	1
33	0	0	0
34	0	0	0
35	0	0	0
36	0	0	0
37	0	0	1
38	0	0	0
39	0	0	1
40	0	0	0
41	0	0	0
42	0	0	0
43	0	0	0
44	0	0	0
45	0	0	0
46	0	0	0
47	0	0	0
48	1	0	0
49	0	0	0
50	1	0	0
51	1	0	0
52	0	0	0
53	2	0	0
54	2	1	0
55	1	0	0
56	0	2	0
57	5	0	0
58	3	4	0
59	7	2	0
60	6	3	0
61	9	10	0
62	5	4	0
63	5	2	0
64	3	2	0
65	1	3	0
66	3	1	0
67	0	2	0
68	4	6	0
69	1	2	0

Table 7B Continued.

Length (cm)	Males	Females	Jacks
70	0	6	0
71	1	4	0
72	1	2	0
73	0	1	0
74	1	2	0
75	2	2	0
76	1	1	0
77	0	0	0
78	0	0	0
79	0	1	0
80	0	1	0
81	0	0	0
82	0	1	0
83	0	0	0
Totals	**66**	**65**	**5**
Mean Length (cm)	61.9	66.3	34.5
Standard Deviation (cm)	5.8	6.3	4.8
Adipose Clips	0	0	1
Mark Rate (%)	0.0	0.0	20.0

Table 8A. Summary of age data from fall run Chinook sampled during the carcass-mark recapture program, lower Nanaimo River, 2008

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2006	2	27	36.0%	0	0.0%	27	17.9%
0.2	2005	3	43	57.3%	55	72.4%	98	64.9%
0.3	2004	4	5	6.7%	20	26.3%	25	16.6%
0.4	2003	5	0	0.0%	1	1.3%	1	0.7%
Total			75	100%	76	100%	151	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 8B. Summary of age data from First lake summer run Chinook sampled during the carcass-mark recapture program, lower Nanaimo River, 2008 ɔvery

European Age [1]	Brood Year	Total Age	Males #	Males %	Females #	Females %	Total #	Total %
0.1	2006	2	5	13.5%	0	0.0%	5	6.2%
0.2	2005	3	27	73.0%	28	63.6%	55	67.9%
0.3	2004	4	5	13.5%	16	36.4%	21	25.9%
Total			37	100%	44	100%	81	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Table 9. Percentage of the tag application sample recovered on the spawning grounds, by application period and sex, lower Nanaimo River, 2008

Application Period	Days of Application	Tag Recovery Male	Tag Recovery Female	Tag Recovery Total	Tag Application Male	Tag Application Female	Tag Application Total	Tag Recovery (%) Male	Tag Recovery (%) Female	Tag Recovery (%) Total
Oct 30 - Nov 6	5	8	12	20	41	63	104	19.51	19.05	19.23
Nov 7 - 14	4	17	32	49	36	47	83	47.22	68.09	59.04
Nov 15 - 22	4	18	36	54	28	71	99	64.29	50.70	54.55
Nov 23 - 30	4	4	10	14	5	14	19	80.00	71.43	73.68
Total		47	90	137	110	195	305	42.73	46.15	44.92

excluding jacks; application totals corrected for sex mis-identification

Table 10. Length-frequency of fall run Chinook sampled from hatchery broodstock, lower Nanaimo River, 2008

Length (cm)	Males	Females	Jacks
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
32	0	0	0
33	0	0	0
34	0	0	0
35	0	0	1
36	0	0	0
37	0	0	3
38	0	0	4
39	0	0	4
40	0	0	5
41	0	0	3
42	0	0	4
43	0	0	0
44	0	0	3
45	0	0	0
46	0	0	1
47	0	0	1
48	0	0	1
49	1	0	0
50	0	0	0
51	0	0	0
52	2	0	0
53	0	0	0
54	3	0	0
55	3	0	0
56	2	2	0
57	1	1	0
58	1	1	0
59	8	7	0
60	0	4	0
61	4	5	0
62	5	1	0
63	5	4	0
64	6	7	0
65	2	7	0
66	4	3	0
67	0	1	0
68	4	4	0
69	1	2	0

Table 10 Continued.

Length (cm)	Males	Females	Jacks
70	1	3	0
71	4	1	0
72	1	3	0
73	1	2	0
74	1	1	0
75	0	5	0
76	0	2	0
77	0	1	0
78	1	1	0
79	0	0	0
80	0	2	0
81	0	0	0
82	0	0	0
83	0	0	0
Totals	**61**	**70**	**30**
Mean Length (cm)	63.1	66.7	41.0
Standard Deviation (cm)	6.0	6.2	2.9
Adipose Clips	3	16	1
Mark Rate (%)	0.0	0.0	20.0

Table 11A. Summary of age data from fall run Chinook broodstock collection, lower Nanaimo River, 2008.

European Age [1]	Brood Year	Total Age	Males		Females		Total	
			#	%	#	%	#	%
0.1	2006	2	30	34.9%	2	2.8%	32	20.4%
0.2	2005	3	47	54.7%	39	54.9%	86	54.8%
0.3	2004	4	9	10.5%	27	38.0%	36	22.9%
0.4	2003	5	0	0.0%	3	4.2%	3	1.9%
Total			86	100%	71	100%	157	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Total number of unreadable scales: 5

Table 11B. Summary of age data from First Lake summer run Chinook broodstock collection, upper Nanaimo River, 2008.

European Age [1]	Brood Year	Total Age	Males		Females		Total	
			#	%	#	%	#	%
0.1	2006	2	4	21.1%	0	0.0%	4	8.5%
0.2	2005	3	15	78.9%	26	92.9%	41	87.2%
0.3	2004	4	0	0.0%	2	7.1%	2	4.3%
Total			19	100%	28	100%	47	100%

[1] The first number indicates the number of annuli formed in freshwater, the second number indicates the number of annuli formed in the ocean (Koo 1962).

Total number of unreadable scales: 3

Table 12. Coded-wire tag data from fall run Chinook sampled during deadpitch on the lower Nanaimo, 2008

Recovery Data				Release Data				
Date	POH (mm)	Sex	E-Label	Tag Code	Brood Year	Hatchery	Start Release Date	End Release Date
21-Oct-08	752	1	5042E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-08	724	1	5043E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
24-Oct-08	756	1	5052E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
29-Oct-08	675	1	5061E	No Pin				
20-Oct-08	732	2	5041E	18-57-24	2004	Puntledge		
6-Nov-08	715	2	5065E	18-57-13	2004	Nanaimo	16-May-05	15-Jun-05
21-Oct-08	712	2	5044E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
24-Oct-08	645	2	5053E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
24-Oct-08	637	2	5051E	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-08	699	2	5058E	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
27-Oct-08	700	2	5057E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
31-Oct-08	623	2	5063E	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-08	680	2	5045E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
22-Oct-08	778	2	5048E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
27-Oct-08	710	2	5055E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
29-Oct-08	699	2	5060E	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
23-Oct-08	695	2	5050E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
27-Oct-08	715	2	5056E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
29-Oct-08	699	2	5062E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
4-Nov-08	662	2	5064E	18-58-03	2004	Nanaimo	19-May-05	15-Jun-05
21-Oct-08	618	2	5047E	No Pin				
27-Oct-08	692	2	5054E	No Pin				
24-Oct-08	615	2	10615E	No Pin				
21-Oct-08	425	3	5046E	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
23-Oct-08	402	3	5049E	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
28-Oct-08	Unk	Unk	5059E	No Pin				

Table 13. Coded-wire tag data from fall run Chinook sampled at the Nanaimo River Hatchery during brood stock collection, 2008.

Recovery Data				Release Data				
Date	Sex (MFJ)	POH (mm)	E Label	CWT Code	Brood Year	Hatchery	Release Start Date	Release End Date
Oct 12/08	F	588	372058	18-44-21	2005	Chemainus		
Oct 8/08	F	656	372059	18-52-10	2005	Chemainus		
Oct 5/08	F	714	372051	18-55-31	2003	Chemainus	17-May-04	18-May-04
Oct 12/08	F	666	372054	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05
Oct 14/08	F	682	372057	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
Oct 12/08	F	685	372050	18-57-15	2004	Nanaimo	19-May-05	15-Jun-05
Oct 12/08	F	738	372062	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
Oct 12/08	F	752	372065	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
Oct 14/08	F	767	372052	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
Oct 16/08	F	805	372067	18-57-16	2004	Nanaimo	19-May-05	15-Jun-05
Oct 8/08	F	744	372056	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
Oct 8/08	F	751	372053	18-57-17	2004	Nanaimo	19-May-05	15-Jun-05
Oct 8/08	F	755	372066	18-58-02	2004	Nanaimo	19-May-05	15-Jun-05
Oct 5/08	F	616	372060	No-Pin				
Oct 8/08	F	734	372063	No-Pin				
Oct 8/08	F	685	372064	No-Pin				
Oct 26/08	J	422	372070	18-60-35	2006	Cowichan		
Oct 16/08	M	491	372061	08-23-44	2005	Puntledge Summer Run		
Oct 20/08	M	577	372068	18-56-51	2005	Big Qualicum		
Oct 22/08	M	732	372069	18-57-14	2004	Nanaimo	16-May-05	15-Jun-05

Table 14. Nanaimo River Hatchery Chinook release data for brood years 1997 - 2007.

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site	Run Type
183220	1997	25,240	70,000	36.06	6.67	5/7/1998	5/7/1998	First Lake	Summer
183221	1997	25,173	99,098	25.4	6	5/15/1998	5/15/1998	First Lake	Summer
183223	1997	28,252	43,881	64.38	6.01	5/26/1998	5/26/1998	Nanaimo R.	Fall
182408	1997	10,050	15,610	64.38	6.01	5/26/1998	5/26/1998	Nanaimo R.	Fall
183222	1997	24,824	24,824	100	15.5	7/23/1998	7/23/1998	Jack Point	Fall
-	1998	0	442,830	0	5.1	5/12/1999	5/13/1999	Nanaimo R.	Fall
-	1998	0	165,595	0	5.61	5/28/1999	5/28/1999	First Lake	Summer
-	1998	0	50,411	0	11	6/2/1999	7/8/1999	Jack Point	Fall
184330	1999	25,185	257,394	9.78	4.03	5/17/2000	5/17/2000	First Lake	Summer
184332	1999	25,071	25,071	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
184331	1999	25,185	25,185	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
184333	1999	25,165	25,165	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
184334	1999	25,231	25,231	100	5.1	5/18/2000	5/18/2000	Nanaimo R.	Fall
-	1999	0	99,238	0	4.8	5/18/2000	5/18/2000	Nanaimo R.	Fall
184335	1999	25,300	126,422	20.01	5	5/5/2000	5/23/2000	Nanaimo R.	Fall
184336	1999	25,115	125,497	20.01	5	5/5/2000	5/23/2000	Nanaimo R.	Fall
184329	1999	25,175	57,625	43.69	10.34	6/23/2000	6/23/2000	Jack Point	Fall
184363	2000	24,739	207,955	11.9	6.56	5/23/2001	5/24/2001	First Lake	Summer
184552	2000	50,060	105,512	47.44	4.9	4/28/2001	5/29/2001	Nanaimo R.	Fall
184554	2000	50,259	105,931	47.45	4.9	4/28/2001	5/29/2001	Nanaimo R.	Fall
184553	2000	50,254	105,920	47.45	4.9	4/28/2001	5/29/2001	Nanaimo R.	Fall
184362	2000	25,091	51,070	49.13	8.67	6/6/2001	6/6/2001	Jack Point	Fall
184717	2001	25,119	102,917	24.41	4.68	5/9/2002	5/9/2002	Nanaimo R.	Fall
184718	2001	25,355	103,883	24.41	4.68	5/9/2002	5/9/2002	Nanaimo R.	Fall
183205	2001	25,182	25,182	100	5.61	5/14/2002	5/14/2002	Nanaimo R.	Fall
183206	2001	25,237	25,237	100	5.61	5/14/2002	5/14/2002	Nanaimo R.	Fall
184337	2001	25,102	186,187	13.48	5.7	5/16/2002	5/16/2002	First Lake	Summer
184715	2001	25,307	25,307	100	3.78	5/16/2002	5/16/2002	Nanaimo R.	Fall
184716	2001	25,131	25,131	100	3.78	5/16/2002	5/16/2002	Nanaimo R.	Fall
184628	2001	25,119	51,508	48.77	6.62	5/17/2002	5/17/2002	Jack Point	Fall
185527	2002	39,650	39,650	100	20	7/31/2003	7/31/2003	Nanaimo R.	Fall
185528	2002	40,226	40,226	100	10	5/31/2003	5/31/2003	Nanaimo R.	Fall
-	2002	0	173,081	0	7.17	5/6/2003	5/19/2003	First Lake	Summer
-	2002	0	324,204	0	6	5/8/2003	5/21/2003	Nanaimo R.	Fall
-	2003	0	187,214	0	6.93	5/18/2004	5/18/2004	First Lake	Summer
-	2003	0	120,199	0	4.86	5/19/2004	5/19/2004	Nanaimo R.	Fall
185713	2004	29,538	38,922	75.89	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185714	2004	29,559	39,146	75.51	5.0	5/16/2005	6/15/2005	Nanaimo R.	Fall
185715	2004	29,392	38,729	75.89	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185716	2004	29,293	38,792	75.51	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185717	2004	29,124	38,763	75.13	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185802	2004	27,774	36,782	75.51	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
185803	2004	24,568	32,535	75.51	5.0	5/19/2005	6/15/2005	Nanaimo R.	Fall
-	2004	0	154,922	0	8.0	5/18/2005	5/19/2005	First Lake	Summer

Table 14 (continued).

Tag code	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site	Run Type
-	2005	0	174,584	0	5.1	5/22/2006	5/23/2006	Nanaimo R.	Fall
-	2005	0	978	0	2.6	5/23/2006	5/23/2006	Nanaimo R.	Fall
-	2005	0	167,936	0	4.5	5/24/2006	5/24/2006	Nanaimo R.	Fall
-	2005	0	2000	0	3	5/24/2006	5/24/2006	Nanaimo R.	Fall
-	2006	0	421,467	0	--	5/23/2007	5/29/2007	Nanaimo R	Fall
-	2006	0	223,745	0	-	5/17/2007	5/17/2007	First Lake	Sum
-	2007	0	134,552	0	5.1	5/16/2008	5/16/2008	Nanaimo R.	Fall
-	2007	0	229,551	0	5.1	5/16/2008	5/16/2008	First Lake	Sum

Table 15. Chemainus River and Cowichan River Chinook release data for brood years 2002 - 2007.

Tagcode	Brood Year	Number Tagged	Number Released	CWT % Marked	Weight (g)	Start Release Date	End Release Date	Release Site	Run Type
185129	2002	25,191	55,331	45.53	10	2003/05/15	2003/05/16	Chemainus R	Fall
185130	2002	25,253	55,394	45.59	10	2003/05/15	2003/05/16	Chemainus R	Fall
185131	2002	25,167	40,850	61.61	7	2003/05/15	2003/05/16	Chemainus R	Fall
185132	2002	25,282	40,966	61.71	7	2003/05/15	2003/05/16	Chemainus R	Fall
185530	2003	49,960	79,417	62.91	11.4	2004/05/07	2004/05/17	Chemainus R	Fall
185531	2003	50,283	79,775	63.03	5.44	2004/05/17	2004/05/18	Chemainus R	Fall
-	2004	0	22,164	0.00	9.5	2005/05/17	2005/05/17	Chemainus R	Fall
-	2005	0	25,807	0.00	9.96	2006/05/15	2006/05/15	Chemainus R	Fall
-	2005	0	23,519	0.00	9.58	2006/05/15	2006/05/15	Chemainus R	Fall
-	2005	0	26,934	0.00	9.97	2006/05/15	2006/05/15	Chemainus R	Fall
-	2006	0	158,668	0.00	-	2007/05/16	2007/05/16	Chemainus R	Fall
-	2007	0	22,818	0.00	10.8	2008/05/15	2008/05/15	Chemainus R	Fall
184918	2002	50,091	383,156	13.07	4.5	2003/04/11	2003/04/11	Cowichan R Upper	Fall
184919	2002	50,186	383,877	13.07	4.5	2003/04/11	2003/04/11	Cowichan R Upper	Fall
185013	2002	24,712	257,226	9.61	5.74	2003/05/26	2003/05/26	Cowichan R Upper	Fall
185014	2002	25,128	261,555	9.61	5.74	2003/05/26	2003/05/26	Cowichan R Upper	Fall
185015	2002	25,102	261,282	9.61	5.74	2003/05/26	2003/05/26	Cowichan R Upper	Fall
185016	2002	25,197	288,668	8.73	6	2003/05/27	2003/05/27	Cowichan R Lower	Fall
185052	2002	25,134	99,918	25.15	7.36	2003/05/28	2003/05/28	Cowichan Bay	Fall
185412	2003	25,144	99,887	25.17	6.54	2004/05/26	2004/05/26	Cowichan Bay	Fall
185660	2003	25,111	197,202	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185661	2003	25,110	197,194	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185662	2003	25,124	197,304	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185663	2003	25,051	196,731	12.73	3.85	2004/04/05	2004/04/05	Cowichan R Upper	Fall
185701	2003	25,168	219,733	11.45	5.3	2004/05/20	2004/05/20	Cowichan R Upper	Fall
185702	2003	24,863	219,261	11.34	5.3	2004/05/20	2004/05/20	Cowichan R Upper	Fall
185703	2003	24,987	219,252	11.40	5.3	2004/05/20	2004/05/20	Cowichan R Upper	Fall
185704	2003	25,029	98,411	25.43	6.65	2004/05/11	2004/05/11	Cowichan R Lower	Fall
-	2003	0	116,307	0.00	2.41	2004/11/08	2004/11/19	Cowichan L Tributaries	Fall

Table 16A. Total adult Chinook returns to the Nanaimo River, 1975-2008.

	Natural Spawners		Hatchery Broodstock		First Nations	Total
Year	Fall	Summer	Fall	Summer[1]	Food Fish Catch	Returns
1975	475	-	-	-	15	490
1976	880	-	-	-	50	930
1977	2380	-	-	-	60	2420
1978	2125	-	-	-	40	2165
1979	2700	-	41	-	23	2764
1980	2900	-	82	-	200	3182
1981	210	-	15	-	100	325
1982	1090	-	62	-	21	1173
1983	1600	-	240	-	30	1870
1984	3000	-	178	-	50	3228
1985	650	-	264	-	185	1099
1986	700	-	258	-	190	1148
1987	400	-	357	-	50	807
1988	650	-	429	-	0	1079
1989	1150	-	402	-	0	1552
1990	1275	-	122	-	0	1397
1991	800	-	135	-	0	935
1992	800	-	377	-	0	1177
1993	850	-	528	-	0	1378
1994	400	-	280	-	10	752
1995	1592[2]	100	311	75	50	2128[3]
1996	990[2]	600	257	167	335	2349[3]
1997	638[2]	600	52	129	0	1419[3]
1998	1011[2]	200	251	89	0	1551[3]
1999	1920[4]	500	242	179	70	2911[3]
2000	596[6]	450	184	162	126	1518[3]
2001	1277[6]	250	165	169	188	2049[3]
2002	946[6]	432	212	205	213	2008[3]
2003	1378[7]	393	82[8]	131[8]	50	2034[3]
2004	1891[9]	200	119[10]	106	220	2549[11]
2005	1239[9]	201	186	122	950	2705[11]
2006	1723[9]	672	220	168	580	3363[11]
2007	2222[9]	220[9]	100	126	225	2893[11]
2008	2281	506	200	189	720	3896[11]

[1] Ocean type only.

[2] Count at enumeration fence minus broodstock removal above the fence.

[3] Fall natural spawners plus fall broodstock removal below the fence, Native food fish catch and summer run estimate.

[4] Mark recapture Petersen estimate.

[5] Mark recapture estimate plus fall broodstock removal, Native food fish catch and summer run estimate.

[6] Adjusted fence count minus broodstock removal above the fence.

[7] Extrapolated fence count, plus adult/jack adjustment, minus broodstock removals above the fence.

[8] Does not include fish released during high water.

[9] AUC estimate minus broodstock removals.

[10] 107 fish from Nanaimo River Mainstem and 12 from Napoleon Creek.

[11] AUC estimate plus summer run estimate, broodstock removals, Native food fish catch.

Table 16B. Total jack Chinook returns to the Nanaimo River, 1995-2008.

	Natural Spawners		Hatchery Broodstock		First Nations	Total
Year	Fall [1]	Summer [2]	Fall	Summer [1]	Food Fish Catch	Returns [3]
1995	3236	200	88	N/A	-	3524
1996	891	-	72	28	-	991
1997	173	-	24	12	-	209
1998	599	-	30	6	-	635
1999	280 [4]	-	3	21	-	304 [5]
2000	992	-	10	6	-	1008
2001	1385 [6]	-	19	27	-	1431
2002	644 [6]	-	15	15	-	674
2003	772 [7]	-	48	8	-	828
2004	190 [8]	-	30	17	-	255
2005	487 [8]	16	58	91	-	654
2006	2716 [8]	120 [9]	66	8	-	2910
2007	1931 [8]	12	44	12	62	2061
2008	843 [8]	133	52	5	-	1033

[1] Count at enumeration fence minus broodstock removal above the fence.

[2] First Lake summer run only.

[3] Natural spawners plus fall broodstock removal below the fence, Native food fish catch and summer run estimate.

[4] Mark recapture Petersen estimate.

[5] Mark recapture estimate plus fall broodstock removal, Native food fish catch and spring run estimate.

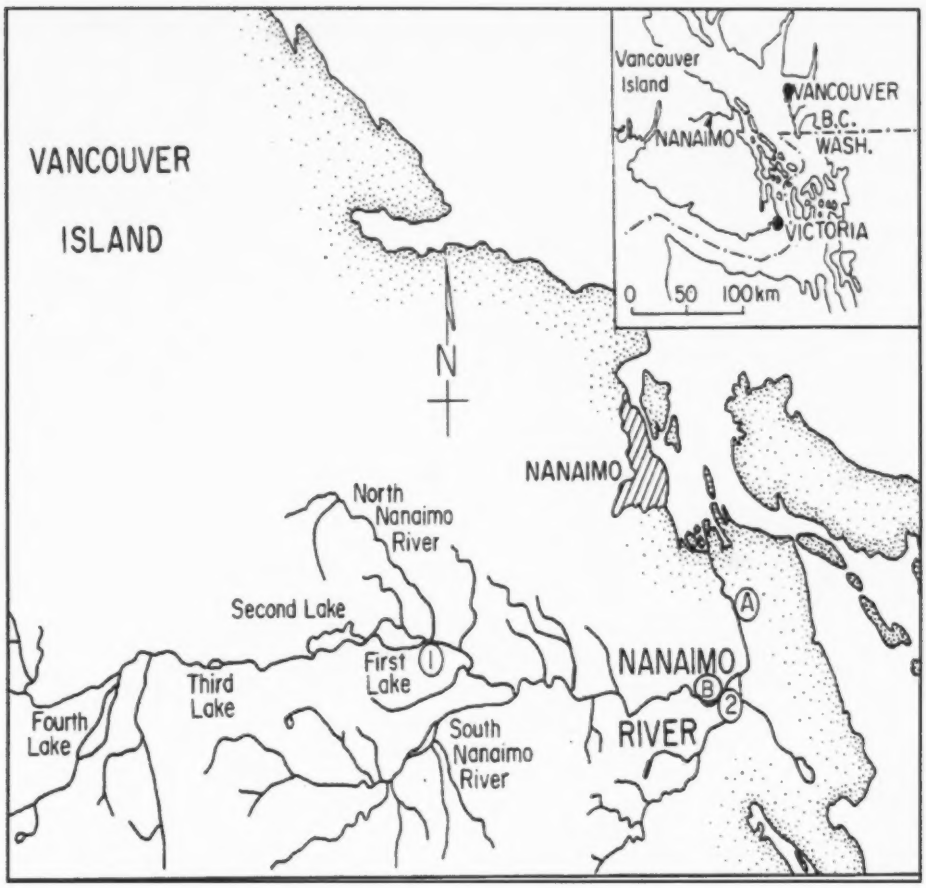
[6] Adjusted fence count minus broodstock removal above the fence.

[7] Extrapolated fence count, plus adult/jack adjustment, minus broodstock removals above the fence.

[8] AUC estimate minus broodstock removals.

[9] Swim Survey Estimate

FIGURES



LEGEND:

1	Hatchery Release Site
2	Hatchery Release Site
A	Enumeration Fence Site (removed 2003)
B	Downstream Fry Trapping Site

Figure 1. Nanaimo River study area.

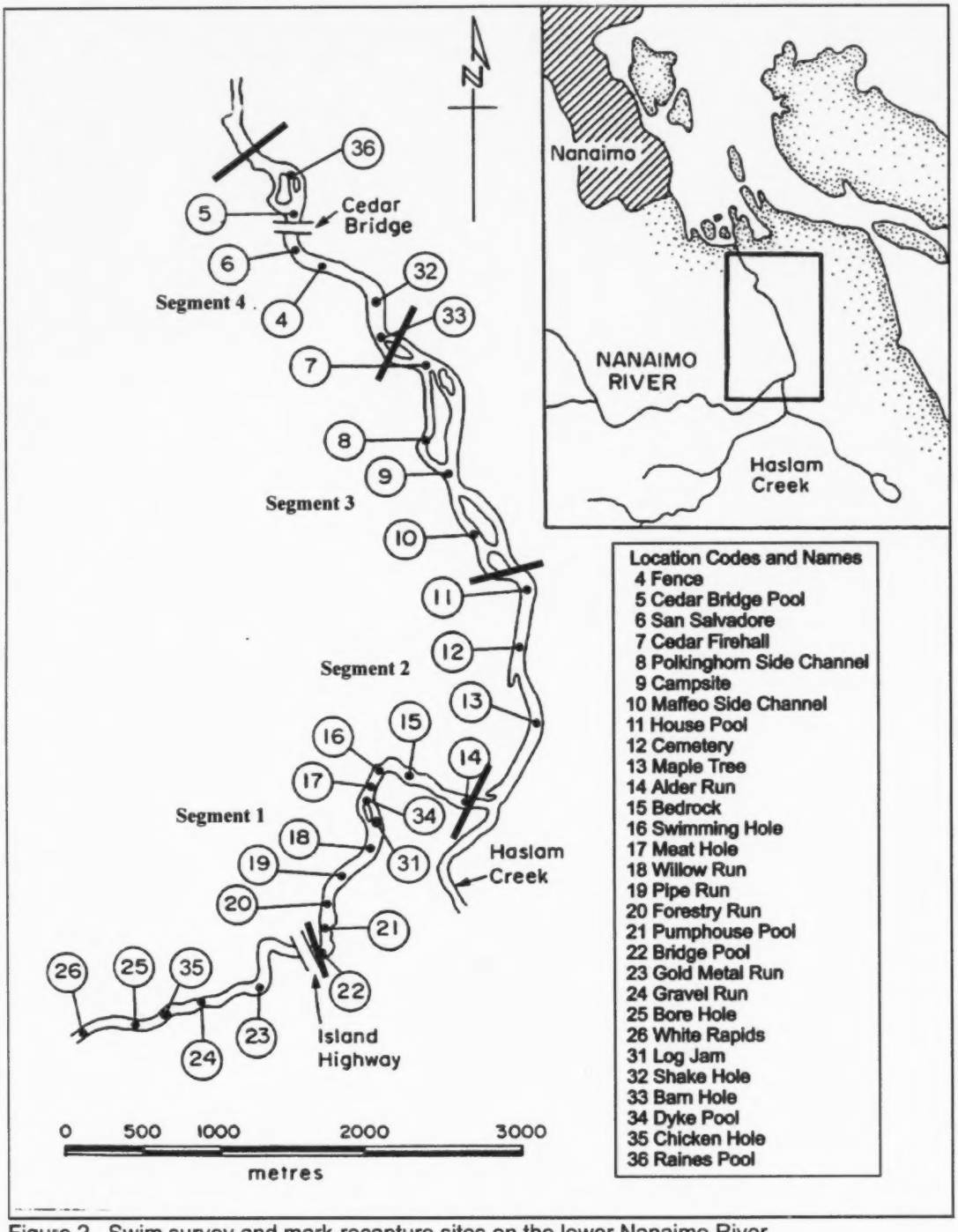


Figure 2. Swim survey and mark-recapture sites on the lower Nanaimo River.

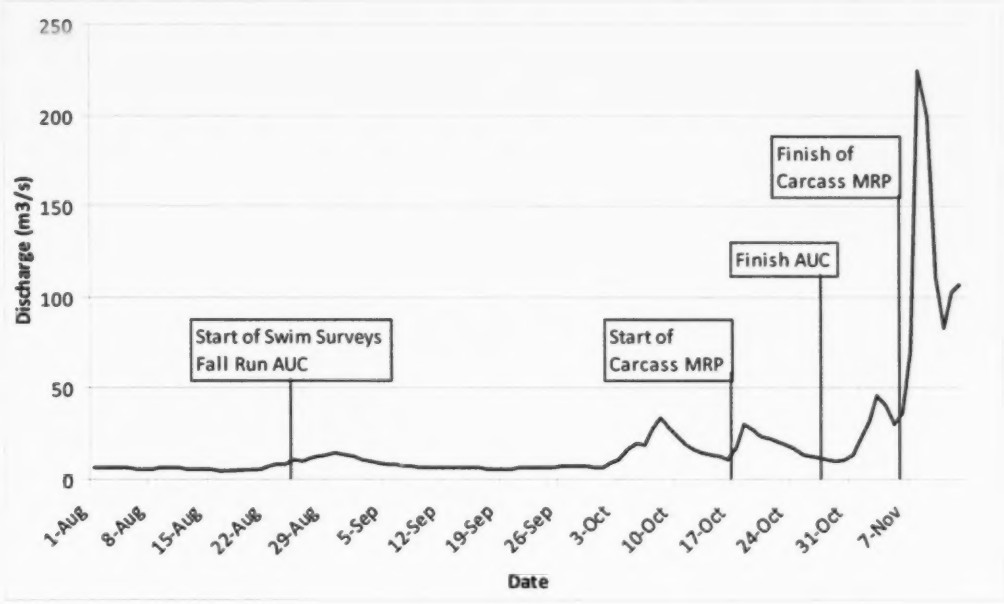


Figure 3. Daily Nanaimo River Discharge (m^3/s) during the fall run Chinook season 2008. Discharge data are preliminary and subject to revision.

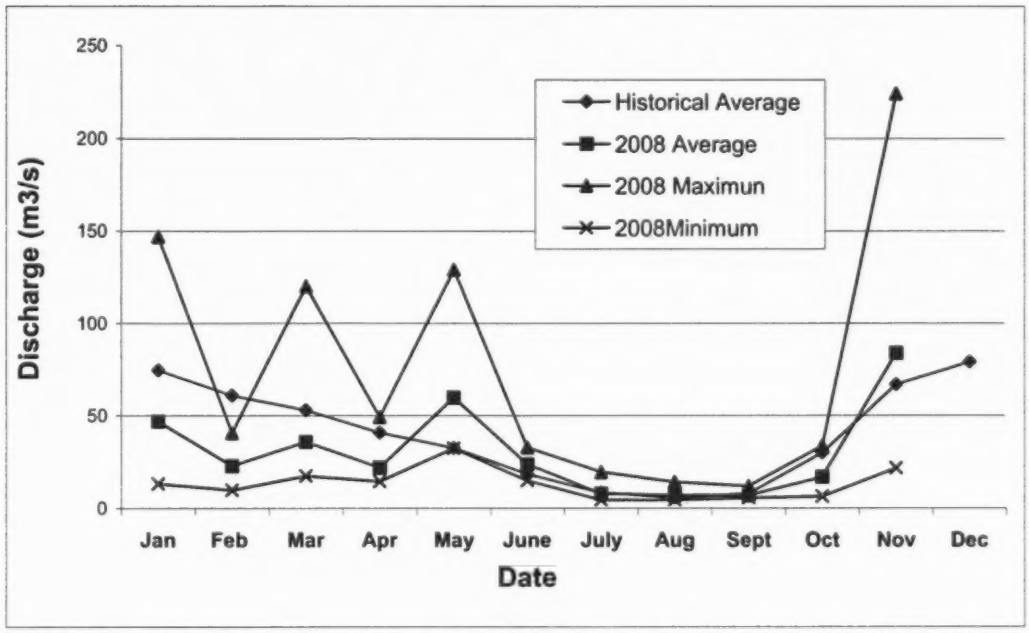


Figure 4. Monthly Nanaimo River discharge (m^3/s) in 2008 along with historic (1965-2007) monthly mean.

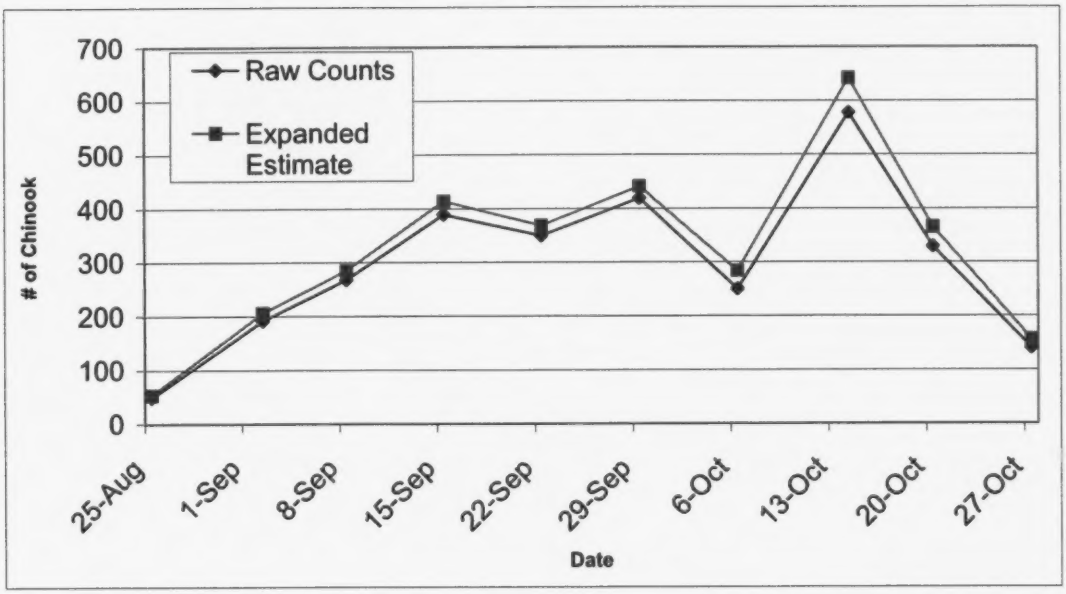


Figure 5. Expanded (for observer efficiency) and raw swim survey counts, lower Nanaimo River in summer/fall 2008.

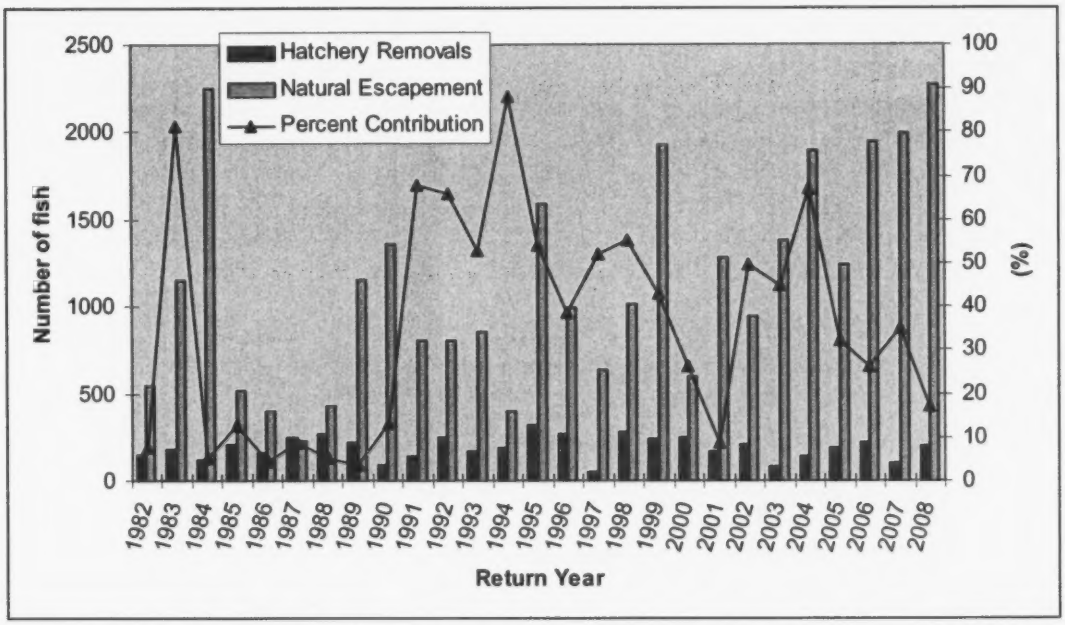


Figure 6. Annual natural and enhanced contribution to fall run Chinook escapement, 1982-2008

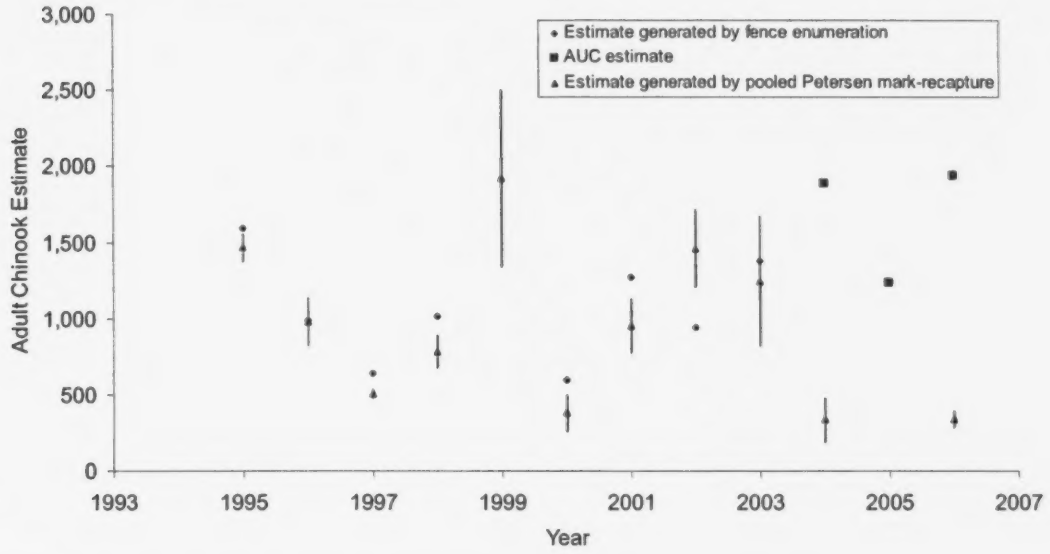


Figure 7. Annual comparisons of fall run adult chinook population estimates generated by fence information, AUC, and mark-recapture pooled Petersen calculations (with 95% confidence intervals), lower Nanaimo River, 1995 - 2006.

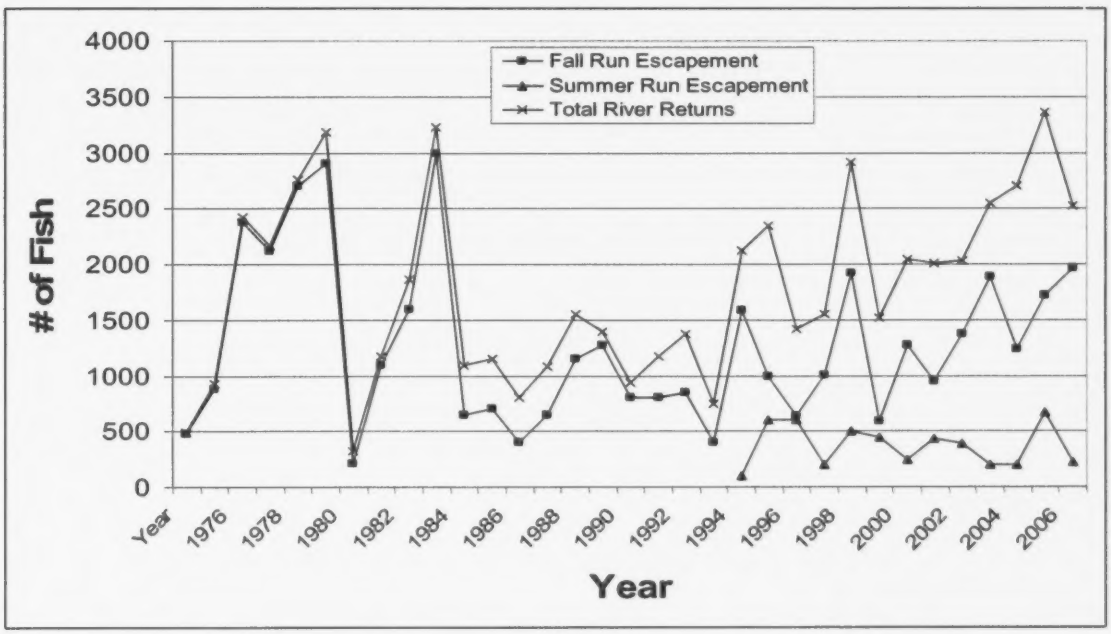


Figure 8. Annual adult fall and summer run Chinook escapements in the Nanaimo River 1975-2007